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A METHOD FOR MERGING THE RESULTS OF NORMATIVE AND POSITIVE MODELS

by

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INTRODUCTION

For many years economists have been discussing the differences between normative and positive models and debating the advantages and disadvantages of these two alternative approaches. This research note does not either review the literature or settle, once and for all, the question of which methodology is the "best". It merely proposes and illustrates a simple rule of thumb that appears to give reasonable answers for agricultural economists who earn a living by doing impact analyses with policy models.

This rule of thumb is designed for use in a "with and without" analysis study. The rule is this:

> Apply the percentage changes obtained from running the normative model "with and without" to the positive model's base line estimates.

INPUT DATA

The input data for the example that will be used to illustrate "Reuben's Rule of Thumb" are illustrated in Table 1. These are based on partial budget and yield impacts developed by a USDA/EPA Assessment Team, that evaluated the short run impacts on yield and variable cost per acre of a ban on using a pesticide for a pest problem in cotton. For the purpose of discussion in this paper, the pesticide will be referred to using the fictitious name, Brand X.

WITH AND WITHOUT ANALYSIS

This input data was utilized to run the NRED interactive version of the ISU LP model as documented by Paul Fuglestad (Using the ISU MODEL Remote

Table 1. Impact of Withdrawing Brand X Pesticide in the Production of Cotton

State	Area 1/ harvested (1976)	With Brand X		Without Brand X			Change in			
							Yield		Cost	
		Average yield 2/	Average Production	Estimated change in production 3/	Production	Average yield	Absolute	Ratio	Total 3/	Average
	th. acres	lb./acre	mill. lb.	mill. lb.	mill. lb.	lb./acre	lb./acre		th. dol.	dol./acre
Alabama	420	412	173.0	-2.1	170.9	406.9	-5.1	.988	+935	+2.23
Arizona	318	1,144	363.8	-0.3	363.5	1143.1	-0.9	.999	-269	-0.85
Arkansas	950	436	414.2	-0.1	414.1	435.9	-0.1	1.000	+435	+0.46
California	No change									
Georgia	240	471	113.0	-8.8	104.2	434.3	-36.7	.922	+622	+2.59
Louisiana	560	470	263.2	+11.1	274.3	489.8	+19.8	1.042	-1,669	-2.98
Mississippi	1,470	479	704.1	-130.7	573.4	390.1	-88.9	.814	+12,201	+8.30
Missouri	No change									
New Mexico	No change									
N. Carolina	71	450	32.0	-5.8	26.2	368.3	-81.7	.818	+376	+5.30
Oklahoma	No change									
S. Carolina	159	455	72.3	-6.1	66.2	416.6	-38.4	.916	-2,583	-16.25
Tennessee	370	349	129.1	+1.7	130.8	353.6	+4.6	1.013	-94	-0.25
Texas	4,508	340	1,530.0	-24.9	1,505.1	334.5	-5.5	.984	19,369	+4.30

1/ Cotton and Wool Situation, Sept. 1977.
2/ 1975-76 avg.; 1973: Ag. Statistics, 1976; 1976: Crop Production, 1976 Annual Summary, SRS.
3/ Unpublished data developed by the Toxaphene Assessment Team.

Access System, 1978).

Earlier versions of the ISU LP model contained "production flexibility" constraints. These constraints forced the solution results on crop acreage within each producing area to fall between prespecified upper and lower bounds. Without the "production flexibility" constraints the LP model would have produced results that appeared to be unrealistic. Quoting Meister and Nichol (A Documentation of the National Water Assesement Model...1975),

> "Regional adjustment restraints are imposed on the model to limit shifts in production between regions ...These restraints simulate farmers' use of multiple cropping alternatives as a means to reduce risk. They also reflect that regional shifts in production are gradual, not instantaneous, due to imperfect mobility of resources...
>
> Downward adjustments in farm production are moderated by the need to recover sunken investments, resistance to change, and the difficulties of shifting occupations and residential location. An annual rate of two percent is considered to be feasible for crop production decreases, whereas upper adjustments requiring replacement of capital investments, new capital, and additional farm labor and management resources are less restricting."

Nichol and Meister's constraints were based on the 1969 Census of Agriculture. For LP runs in the year 1985 they take the form

$$70\% \text{ of } 1969 \leq 1985 \text{ LP solution acreage} \leq 200\% \text{ of } 1969.$$

The positive view of these flexibility constraints is that they impose a reasonable and recognizable reality on an otherwise unrealistic abstract model. The negative view is that these are arbitrarily selected fudge factors that prevent the model from achieving a least cost solution.

(Personally, I believe that they inject a reasonable level of human judgment into an otherwise objective mathematical model).

In the version of the ISU LP model that was used in the Brand X analysis, "Reuben's Rule of Thumb" is used in place of the production flexibility constraints. The percent changes in economic indices that were obtained from running the ISU LP model "with and without" Brand X on cotton were applied to a NIRAP baseline. The NIRAP model produces the official USDA core projections for production, acreage and yield. It is a positive model which is used here to project what will happen "with" Brand X.

EMPIRICAL RESULTS

Numerical Results

Table 2 illustrates the results of the Brand X analysis. The first column of numerical results contains the LP baseline solution for 1985; the second column contains the LP solution for cotton if Brand X is banned. The third column contains the yield ratio from Table 1. The fourth column contains the NIRAP baseline figures. The fifth column contains the numbers obtained by adjusting the NIRAP baseline by an amount equal to the LP "with and without" % changes. The % changes are shown in the next column and the actual differences are shown in the last column.

Reuben's Rule of Thumb

"Reuben's Rule of Thumb" works this way. Let,

P = production in thousands of bales,

A = acreage in thousands of harvested acres,

Y = yield per harvested acre,

K = an upper bound on acreage flexibility; in this study it was arbitrarily set =2,

B = a subscript refering to LP baseline,

N = a subscript refering to new LP results; i.e., "without" Brand X,

Q = a subscript indicating the NIRAP baseline figure,

R = a subscript indicating the results obtained by impacting the NIRAP baseline with the LP percent changes,

E = a subscript indicating results obtained from EPA/USDA Assessment Team

1. Is $(A_N \div A_B) \leq K$? If "yes" go to step "2".

   If "No",

   $A_R = K \cdot (A_Q)$

   $Y_R = (Y_E \text{ "without"} \div Y_E \text{ "with"}) \cdot Y_Q$

   $= \text{Table 1 Yield Ratio} \cdot Y_Q.$

   Go to step "4."

2. (a) $A_R = A_Q + ((A_N - A_B) \div A_B) \cdot A_Q.$

   (b) If A_n and A_B are equal to zero, $A_R = A_Q.$

3. $Y_R = (Y_N \div Y_B) \cdot Y_Q$

4. $P_R = A_R \cdot Y_R$

5. Percent changes between the LP adjusted NIRAP "without" and the 1985 NIRAP Base "with" are computed as follows and printed in the last column of Table 2:

   a. For production: $((P_R-P_Q) \div P_Q) * 100$;

   b. for acreage $((A_R-A_Q) \div A_Q) * 100$; and

   c. for yield $((Y_R - Y_Q) \div Y_Q) * 100$.

Interpretation of Output

The output of the LP analysis appears to be reasonable when compared with other studies done to date. For example, a run of the CED Cotton Model by Neihaus and Reichelderfer that was conducted to evaluate the impacts of the same pesticide policy showed cotton acreage moving out of the Southwest and Delta producing regions and into the West, just as our LP analysis does; the amplitude of the LP acreage shifts is greater than the magnitude of the Cotton Model acreage shifts.

The primary difference in the output of the two models occurs in the Southeast (N. Carolina, Virginia, S. Carolina, Georgia, Florida, Alabama). Here the Cotton Model shows annual acreage declines averaging -8% below baseline figures over the next five years whereas the LP model shows acreage in this region increasing by about 47%. The LP results in the Southeast show acreage holding in all states but Alabama—the major producer in that region. The LP model suggests

that in Alabama, cotton acreage will double, while soybean acreage declines by 30%.

Evaluation of LP Adjusted NIRAP Figures

The LP adjusted NIRAP figures appear to be more realistic than the stand alone LP "without" statistics. For example: The LP ("with" and) "without" statistics for N. Carolina show no cotton harvested in that State; the (NIRAP and) LP adjusted NIRAP figures show cotton acreage in N. Carolina. Since we know that cotton is currently being produced in N. Carolina, the LP adjusted NIRAP figures correspond more closely to the current state of the world. The LP adjusted NIRAP statistics indicate that this State's cotton production will be down by 18% due to an 18% reduction in yield.

The LP adjusted NIRAP figures appear to be more realistic than what could be obtained from adjusting the NIRAP historical state share figure by the yield changes alone. The LP model allows interregional shifts in land use and, hence, production to respond to changes in interregional comparitive advantage.

It is also interesting to compare the original NIRAP baseline at the aggregate U.S. level with the LP adjusted NIRAP figures at the bottom of Table 2. One would expect aggregate cotton production to be fairly inelastic. Sure enough, at the national level average yield is down by 1.8%, acreage is up by 2.0% and there is only a .2% change in aggregate production. These appear to be reasonable figures. If in future

applications of "Reuben's Rule of Thumb", the "whole" (i.e., the baseline NIRAP statistics) is (less than or greater than the "sum of the parts" (i.e., the LP adjusted NIRAP statistics) by a factor equal to F percent, the LP adjusted NIRAP figures can be further adjusted down (or up) by a factor equal to F percent or any other "fudge factor" that the analyst deems appropriate.

MY CONCLUSIONS

The LP adjusted NIRAP statistics appear to be "better" than what could have been obtained from using either model by itself in this analyst's personal opinion. Although the two models chosen for this example are the ISU LP and the NIRAP systems, "Reuben's Rule of Thumb" may be appropriate for other combinations of normative and positive models.

It should be a useful tool for those applied economists who "want numbers badly". As the saying goes, "If you want numbers badly, you will get bad numbers". However, until the day that an operational, hybrid, normative-positive model arrives, I challenge anyone to come up with a better procedure. Critical responses to this paper and challenge are sought and expected.

REVIEW COMMENTS

This "off the wall" paper and ostentatious challenge were given to a "distinguished panel of experts"—Austin Fox and Allen Smith, NEAD; Bill Bogges and Wen-Yuan Huang, Iowa State University; and

Norm Starler and Klaus Alt, NRED. Bill Boggess' views on the subject conformed to the opinions expressed by others:

"1. I agree that a hybrid normative-positive model holds the most promise in this area.

2. The next best solution is an L.P. with acreage flexibility coefficients based on economic variables. Unfortunately, these appear to be nonexistant or very difficult to specify as unpublished research by others (Paul Fuglestad and Wen-Yuan Huang) indicates.

3. Given the absence of (1) or (2), I think the next best alternative is to use endogenous arbitrary production constraints such as those used in the National Water Assessment models. This not only forces the historical distribution of production to reflect historical patterns, but the rest of the results from the L.P. (i.e., resource use, shadow prices, etc.) are consistent with the final production figures.

4. The main problems with the "Rule of Thumb" as I see them are:

   (a) you are mixing positive and normative models without integrating them;

   (b) you are still forced to set arbitrary upper and lower constraints on acreage shifts;

   (c) by applying the percentage changes from the LP to the NIRAP baseline to get new regional production, the rest of the output from the LP (i.e., resource use, shadow prices, etc.) is inconsistent with the new regional production levels."

I agree with most of Bill's comments. This "rule of thumb" does require the use of some arbitrary judgment and it does result in some inconsistencies; hence the name, "rule of thumb." One of the advantages of using the "rule of thumb" in lieu of the approach specified in "3", above occurs in the instance where an agency uses a positive model to produce an official baseline forecast or projection. In this situation,

Table 2. Stand A

			Base LP	New LP	Yield ratio	1985 NIRAP Base	LP Adjusted NIRAP	LP-1985 NIRAP % Change	Value of Change
1	Illinois	P	0	0		1.16	1.16	0.0	0.0
		A	0	0		.80	.80	0.0	0.0
		Y	0	0		1.43	1.43	0.0	0.0
2	Missouri	P	968.86	963.64		245.09	241.93	-1.3	-3.16
		A	597.54	597.54		229.66	229.66	0.0	0.0
		Y	1.62	1.61		1.06	1.05	- .9	-.01
3	Virginia	P				1.74	1.74	0.0	0.0
		A				2.75	2.75	0.0	0.0
		Y				.63	.63	0.0	0.0
4	N. Carolina	P				116.26	94.36	-18.8	-21.9
		A				153.81	153.81	0.0	0.0
		Y			.818	.75	.614	-18.1	-.1
5	Kentucky	P	13.17	13.09		2.55	2.52	-1.2	-.03
		A	8.18	8.18		1.75	1.75	0.0	0.0
		Y	1.60	1.59		1.45	1.44	- .7	-.01
6	Tenn.	P	1036.03	1069.09		356.94	366.78	2.8	9.84
		A	643.49	670.92		340.38	354.89	4.3	14.51
		Y	1.60	1.59		1.04	1.03	-.96	-.01
7	S. Carolina	P				244.16	223.03	-8.7	-21.1
		A				261.82	261.82	0.0	0.0
		Y			.916	.93	.85	-8.6	-.08
8	Georgia	P				348.80	318.49	-8.7	-30.31
		A				375.47	375.47	0.0	0.0
		Y			.922	.92	.84	-8.7	-.08
9	Florida	P				11.62	11.62	0.0	0.0
		A				11.44	11.44	0.0	0.0
		Y				1.01	1.01	0.0	0.0
10	Alabama	P		264.76		465.06	913.39	96.4	448.3
		A		183.86		466.91	933.82	200.0	466.91
		Y		1.43	.988	.99	.98	-1.0	-.01
11	Miss.	P	48.23	50.42		1710.75	1795.73	5.0	84.98
		A	29.80	31.86		1388.12	1484.08	6.9	95.96
		Y	1.61	1.58		1.23	1.21	-1.6	-.02
12	Arkansas	P	2533.36	2519.37		1046.40	1046.40	0.0	0.0
		A	1564.22	1564.22		1014.54	1014.54	0.0	0.0
		Y	1.61	1.61		1.03	1.03	0.0	0.0
13	Louisiana	P	297.93	.49		581.33	9.35	-98.4	-571.98
		A	167.57	.48		514.15	14.40	97.2	-499.75
		Y	1.77	1.02		1.13	.65	-42.5	-.48
14	Oklahoma	P	765.01	638.94		230.20	188.97	-17.9	-41.23
		A	818.88	688.30		324.66	272.89	-15.9	-51.77
		Y	.93	.92		.70	.69	-1.4	-.01
15	Texas	P	5511.52	5574.76		3587.54	3597.07	.3	9.53
		A	4092.48	4130.87		3831.87	3867.82	.9	35.95
		Y	1.34	1.34		.93	.93	0.0	0.0
16	N. Mexico	P	45.11	124.65		156.96	313.92	100.0	156.96
		A	31.83	86.31		142.91	285.82	100.0	142.91
		Y	1.41	1.44	1.0	1.09	1.09	0.0	0.0
17	Arizona	P				788.05	788.05	0.0	0.0
		A				402.67	402.67	0.0	0.0
		Y			.999	1.95	1.95	0.0	0.0
18	Nevada	P				2.32	2.32	0.0	0.0
		A				.95	.95	0.0	0.0
		Y				2.42	2.42	0.0	0.0
19	California	P				1762.96	1762.96	0.0	0.0
		A				909.85	909.85	0.0	0.0
		Y				1.93	1.93	0.0	0.0
				U.S. PRODUCTION		11,659.37	11,679.79	.2	19.92
				U.S. ACREAGE		10,374.51	10,577.23	2.0	202.72
				U.S. YIELD		1.12	1.10	-1.8	-.02

Note: P = Production in thousands of bales
A = Harvested Acreage in thousands
Y = Yield in bales per harvested acre.

applying the "rule of thumb" allows the results of the impact analysis to be consistent with official baseline estimates.

In another comment, not covered by Bill's remarks, Klaus points out the fact that the arbitrary coefficient, K, used in this paper is an upper bound on acreage flexibility. He suggests that the "rule of thumb" should also employ an arbitrary lower bound, L. This would allow the analyst to use a preliminary step, let's call it step 0, in the methodology; i.e.

0. Is $(A_N \div A_B) < L$? If "no", go to step "1."

   If "yes,"

   $A_R = L \cdot (A_Q)$

   $Y_R = (Y_E \text{ "without"} \div Y_E \text{ "with"}) \cdot Y_Q$

   = Table 1 Yield Ratio $\cdot Y_Q$.

This is a good idea.